

BL1.4.3: 10-micron spot size achieved for high spatial resolution FTIR spectromicroscopy

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INTRODUCTION

Synchrotron-based infrared (IR) beamlines provide considerable brightness advantages over conventional IR sources. This brightness advantage manifests itself most beneficially when measuring very small samples. In the commissioning of ALS beamline 1.4.3, we have experimentally measured the small spot-size obtained by our IR microscopy system when using the synchrotron beam and we compare it to the internal Globar source. Here we demonstrate this tight focus and the factor of ~100's improvement over conventional sources in measured signal through very small apertures.

ACHIEVED SPOT SIZE

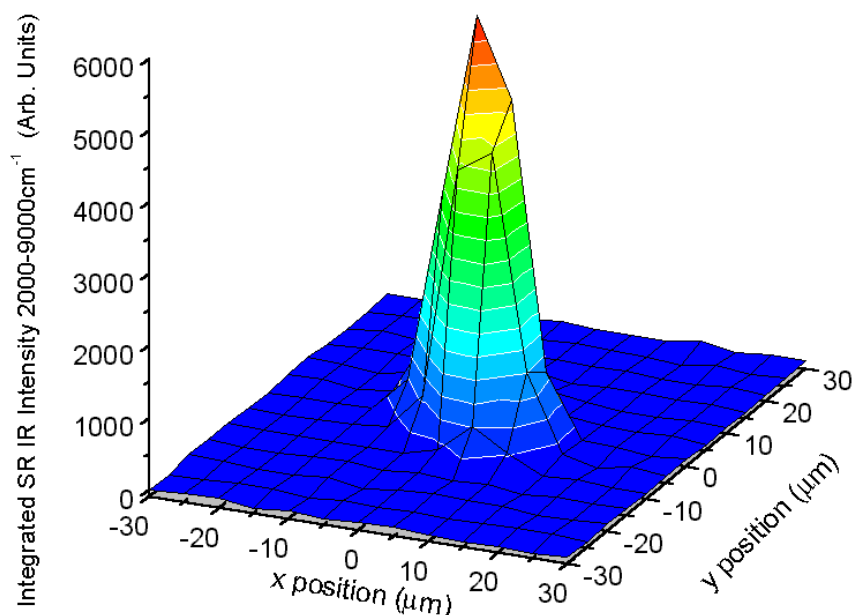


Figure 1. Integrated IR signal intensity from 2000 - 9000cm⁻¹ through a 10μm pin hole being scanned on microscope stage. There are no other apertures in the optical path. This graph demonstrates the small spot size achieved using the synchrotron IR beam

We have made measurements to determine the small spot sizes achievable with the infrared microspectroscopy set-up on Beamline 1.4.3. The spectrometer software can take an area scan by moving the sample stage with 1 micron spatial resolution under the focused IR beam and acquiring FTIR spectra at each point. To determine the actual focused spot size of the synchrotron beam and compare it to the internal Globar IR source, we used a 10μm pin hole and measured the transmitted spectra as a function of the pin hole position. No other beam-defining apertures were used.

By integrating over the measured energies, we obtain an intensity number. The intensity as a function of pin hole position is shown above in Figure 1. We clearly have a nice small spot being produced by our optics. In Figure 2 (below) we plot the x and y profiles of this spot along with fits to a Gaussian line-shape. The data fits very well to a Gaussian line-shape with resultant widths of $10\mu\text{m}$ in x and $8\mu\text{m}$ in y. This spot size is becoming roughly diffraction-limited for the low-energy end of our detection capabilities ($1000\text{cm}^{-1} = 10\mu\text{m}$ wavelength).

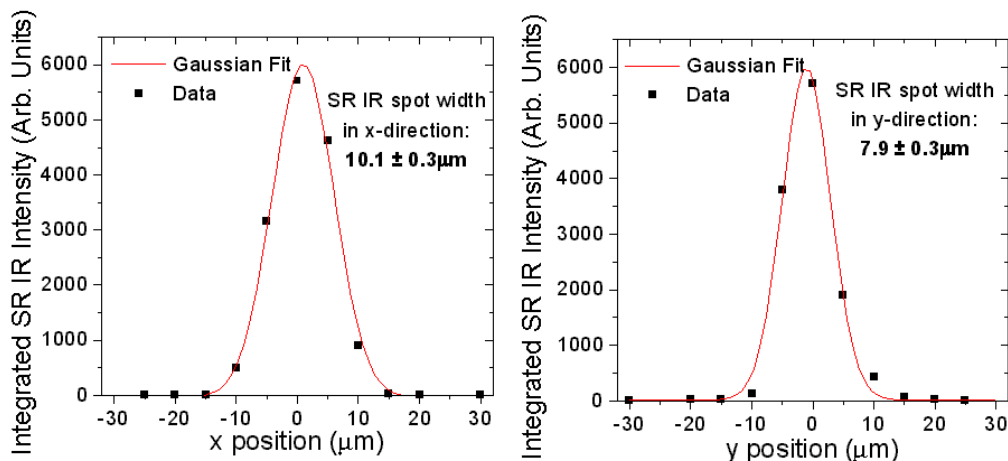


Figure 2. Peak shape profiles in the x (left panel) and y (right panel) directions. We observe a well-defined Gaussian peak shape with widths of $10\mu\text{m}$ in x and $8\mu\text{m}$ in y.

When we compare the above measurements to similar measurements made with a conventional Globar IR source, the brightness advantages of the synchrotron become readily apparent. The Globar has a much broader peak profile of around $100\mu\text{m}$ in width simply due to the large source size of this glowing filament source making a better focus impossible. Therefore, while the overall amount of light passing through the optical system from the Globar and the synchrotron sources is comparable, nearly all of the synchrotron light can be focused onto a $10\mu\text{m}$ spot. To achieve a similar spot size using the conventional Globar source, one must simply mask down the apertures and throw away a factor of lot of signal intensity. We measure improvements of several hundred in intensity through small pin-holes ($5\mu\text{m}$ and smaller) for the synchrotron source compared to the Globar.

CONCLUSION

When high spatial resolution infrared experiments are of interest, Beamline 1.4.3 provides a huge gain in the available signal.

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